2. WASTE DESCRIPTION

2.1 TYPES OF WASTE

The types of waste that will be delivered to the repository for disposal consist of commercial spent fuel (including mixed oxide spent fuel), high-level waste (including immobilized plutonium), and DOE spent fuel (including Naval spent fuel). Their characteristics vary appreciably in form, radioactive content and condition. Due to age and degradation, some of the DOE spent fuel may require conditioning or stabilization before it can be accepted for disposal in the repository.

Other waste forms that could potentially require disposal are being evaluated as contingencies. These include Greater-Than-Class-C low-level waste, cesium/strontium capsules, and DOE Special Performance Assessment Required Waste.

2.1.1 COMMERCIAL SPENT FUEL

Most of the commercial spent fuel consists of fuel assemblies discharged from 78 pressurized water reactors (PWRs) and 40 boiling water reactors (BWRs). This spent fuel is located at 72 nuclear power plant sites and one independent storage site in 33 states. The total amount of spent fuel in inventory as of 1996 is estimated at 12,100 MTHM in BWR fuel assemblies and 22,150 MTHM in PWR assemblies (DOE 1997). By 2030, the amount of spent fuel in inventory is projected to be 86,700 MTHM in BWR and PWR assemblies. The actual amount of spent fuel to be discharged could exceed the projected amount if reactor life extension programs are authorized by the Nuclear Regulatory Commission and implemented by the utilities. Conversely, the amount of spent fuel could be less than projected if reactors are shut down prematurely. Table 1 shows some typical characteristics of commercial spent fuel.

Table 1. Typical Commercial Spent Fuel Characteristics[a]

Characteristic	BWR	PWR
Overall assembly length, m (ft)	4.47 (14.67)	4.06 (13.32)
Cross section, cm (in)	13.9x13.9 (5.5x5.5)	21.4x21.4 (8.4x8.4)
Fuel rod length, m (ft)	4.06 (13.32)	3.85 (12.63)
Fuel rod array	8x8	17x17
Fuel rods per assembly	63	264
Assembly total weight, kg (lb)	319.9 (705.4)	657.9 (1,450.7)
MTHM per assembly	0.183	0.461
Nominal volume per assembly, m^3 (ft^3)	0.0864 (3.0508)	0.1860 (6.5677)

[a]Reference DOE 1997

The commercial spent fuel to be delivered to the repository includes both fuel assemblies and other waste forms. The other waste forms include canisters containing intact spent fuel assemblies,

consolidated spent fuel assemblies, spent fuel rods or pieces, or other fuel and nonfuel components. These canisters are stored in racks in the reactor spent fuel pools.

2.1.2 HIGH-LEVEL WASTE

The high-level waste to be disposed of is vitrified and encased in metal canisters by both commercial and defense waste generators. The types of canisters to be used for commercial and defense high-level wastes are those shown in Table 2.

Table 2. High-Level Waste Canister Characteristics and Projections

	CHLW	DHLW		
	WVDP[b]	SRS[c]	HANF[d]	INEEL[e]
Number of canisters in 2035[a]	300	5,940	12,200	1,190
Canister Length, cm (in)	300 (118)	300 (118)	450 (177)	300 (118)
Outside Diameter, cm (in)	61 (24)	61 (24)	61 (24)	61 (24)
Loaded Weight, kg (lb)	2,200[f] (4,850)	2,200[f] (4,850)	3,700 (8,160)	2,300[f] (5,070)

[a] Reference DOE 1997
[b] Commercial high-level waste (CHLW) from the West Valley Demonstration Project (WVDP)
[c] Defense high-level waste (DHLW) from the Savannah River Site (SRS)
[d] Defense high-level waste from the Hanford Site
[e] Defense high-level waste from Idaho National Engineering and Environmental Laboratory (INEEL)
[f] Reference ORNL 1992

It is estimated that about 19,630 canisters will be produced through 2035. (This estimate does not include the number of canisters that will contain about 17 metric tons of immobilized plutonium). However, there is currently some uncertainty in the exact number of high-level waste canisters that will ultimately be produced. Production of canisters of commercial and defense high-level waste has already begun at the West Valley Demonstration Project in New York and at the Defense Waste Processing Facility at the Savanah River Site, respectively. Wastes from these two facilities are in the form of borosilicate glass encased in stainless steel canisters. Production of waste canisters is also planned at both the Hanford Site and at the Idaho Chemical Processing Plant of the Idaho National Engineering and Environmental Laboratory. The reference waste form for these two sites is also a glass form, but final decisions on their characteristics and canister sizes have yet to be made.

2.1.3 DOE SPENT FUEL

DOE spent fuel includes fuel from defense production reactors, Navy propulsion reactors, domestic and foreign research reactors, commercial reactors, the Fort St. Vrain High Temperature Gas-Cooled

Reactor, and debris from the Three Mile Island Unit 2 reactor. The DOE spent fuel inventory projected to the year 2035 totals about 2,502 MTHM (DOE 1998b). Table 3 provides a summary of the types and amounts of DOE spent fuel that will be available by 2035.

Table 3. Types and Amounts of DOE Spent Fuel

DOE SNF Category	Representative SNF Type	Mass (MTHM)	Volume m^3 (ft^3)
1. Uranium Metal Matrix, Zirconium or Aluminum Clad	N-Reactor SNF, Single Pass Reactor SNF	2,122	209 (7,380)
2. Uranium Alloy Fuel with Zirconium Clad	Heavy-Water Cooled Test Reactor	<1	1(35)
3. Uranium Molybdenum Matrix, Zirconium Clad	Fermi Core	4	<1(--)
4. Uranium Oxide Matrix, Zirconium or Stainless Steel Clad	Intact Commercial SNF	99	52 (1,836)
5. Uranium Oxide Matrix, Failed Clad or Declad	Three Mile Island Core 2 Debris	87	241 (8,510)
6. Uranium Aluminum or Uranium Oxide Matrix, Aluminum Clad	Advanced Test Reactor SNF	9	150 (5,300)
7. Uranium-silicide, Aluminum Clad	Foreign Research Reactor - Material Test Reactor	12	53 (1,871)
8. Uranium-Carbide/ Thorium-Carbide Matrix, Graphite Clad in Good Condition	Fort St Vrain SNF	25	212 (7,486)
9. Uranium-Carbide/Thorium-Carbide Matrix, Graphite Clad in Unknown Condition	Peachbottom SNF	2	17 (600)
10. Uranium and Uranium-Plotunium Carbide	Fast Flux Test Facility Carbide Fuel Compounds	<1	<1(--)
11. Mixed Oxide Matrix	Fast Flux Test Facility Oxide Fuel Compounds	12	36 (1,271)
12. Uranium-Thorium Oxide Matrix, Zirconium or Stainless Steel Clad	Shippingport Light Water Breeder Reactor SNF, Pathfinder SNF	50	18 (636)
13. Uranium-Zirconium Hydride Matrix	Training Reactor, Isotopics, General Atomics (TRIGA)	2	8 (282)

14. Sodium Bonded[a]	Experimental Breeder Reactor II Driver	--	--
15. Navy Propulsion Reactor SNF	Navy SNF	65	888 (31,356)
16. Miscellaneous SNF	Various one-of-a-kind SNF	11	20 (706)
Total[b]		2,502	1,907 (67,337)

[a]Totals do not include 60 MTHM/27 m^3 (953 ft^3) Metallic Sodium Bonded Experimental Breeder Reactor II SNF and Fermi Blanket, and 151 MTHM/97 m^3 (3,425 ft^3) of Canyon Stabilization with EM Record of Decision (Savannah River Site Driver Fuel & Targets, EBR II Targets), which are candidate fuels for treatment or processing prior to disposal.
[b]Totals may not sum due to rounding

2.2 AMOUNT OF NUCLEAR WASTE DESTINED FOR THE FIRST REPOSITORY

The statutory limit of 70,000 MTHM of nuclear waste to be emplaced in the first repository, until a second repository is in operation, has been allocated as shown in Table 4.

Table 4. Amount and Type of Waste to be Emplaced

Type	Amount (In MTHM or Equivalent)
Commercial SNF[a]	63,000
Commercial HLW	640
Defense HLW[b]	4,027
DOE and Naval SNF	2,333
Total	70,000

[a]May include some mixed oxide spent fuel
[b]May include some immobilized plutonium

The allocations are for a repository designed to emplace only a portion of the Nation's projected total nuclear waste inventory. Section 5 will focus on a repository that will emplace all of the projected nuclear waste inventory.